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Comparison of the clinical and radiological results of posterior cruciate ligament-retaining and posterior cruciate ligament-stabilized knee arthroplasties

Comparison of two different knee prothesis

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Abstract
Aim: Total knee arthroplasty (TKA) is one of the most successful orthopedic surgeries. To further improve these outcomes, researchers have developed various types of prosthetics. This study aims to compare the clinical and radiological results of the common posterior cruciate ligament (PCL)-retaining (CR) and PCL-stabilized (PS) knee arthroplasties.
Material and Methods: We retrospectively evaluated the data of patients that were diagnosed with gonarthrosis in our clinic and who underwent knee replacement. The patients were evaluated using the American Knee Society score (AKSS) and radiographic assessment.
Results: There were a total of 115 subjects. Fifty-nine knees of 54 patients and 80 knees of 61 patients were included in the study. Forty-six of the 54 patients in the ligament-retaining group were female (86%) and 8 were male (14%). Fifty-two of the 61 patients in the ligament-stabilized group were female (85%) and 8 were male (15%).
The mean age was 67.4 years (54-82) in the ligament-retaining group and 65.4 years (42-85) in the ligament-stabilized group. The mean follow-up time in both groups was 32.6 months (12-98).
Discussion: The comparison of PCL-retaining and PCL-stabilized knee arthroplasties revealed that the ligament-stabilized group was superior in terms of the range of motion. The radiological examination revealed a difference in component alignment. The two groups did not differ significantly regarding other parameters.

Keywords
Knee; Arthroplasty; Prosthesis; PCL; Cruciate

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Introduction

Total knee arthroplasty aims to achieve two main objectives: to reduce pain and improve knee function, and to provide proper alignment [1]. However, researchers have been constantly discussing possible treatment options to achieve these goals. Each type of prosthesis has its own set of advantages and disadvantages [2-6]. The most popular knee prosthesis designs include PCL-retaining and PCL-stabilized knee arthroplasties [7]. These two types of prostheses have similar geometric designs in general; however, many researchers have studied the two approaches, especially in the context of the role of the posterior cruciate ligament. PCL-retaining and PCL-stabilized knee arthroplasties are not only different in concept but also in practice. However, the surgeon's choice of the prosthesis depends more on surgeon's experience, than the attributes of the prosthesis type [8]. We designed this study considering that the clinical and radiological outcomes of these inherently different designs will also be distinct.

This study aims to compare the clinical and radiological results of the PCL-sacrificing and PCL-sparing knee arthroplasties.

Material and Methods

The study included patients who presented to our clinic with knee pain and were diagnosed with gonarthrosis radiologically, who had previously tried conservative methods of treatment, but had undergone knee arthroplasty as they no longer responded to conservative treatment. The patients that were operated with revision systems and those whose data were not found were excluded from the study.

All subjects were preoperatively evaluated with both AP and PA weight-bearing radiography of the knee. Other than routine monitoring of the patients with comorbidities, all patients were evaluated for infection parameters before surgery. Preoperative sedimentation rate and C-reactive protein levels were evaluated. All patients were preoperatively administered cefazolin 1 g IV 30 minutes before surgery and postoperatively continued to use cefazolin for 3 days. In all patients, a midline incision was made, and bony structures were revealed with a medial parapatellar incision. A tourniquet was used in all patients during the operation. Smith & Nephew cemented knee replacements were used in all patients. The patellar joint surface was not replaced in any of the subjects. However, patellar denervation was achieved with electrocautery in all subjects. All operations were performed by the same surgeon. General anesthesia was applied to 12 ligament-stabilized patients and 3 ligament- retaining patients, all other patients were operated on under spinal anesthesia.

Postoperative surgical drains were used. The drains were removed on postoperative day 1, and the patients were mobilized with walkers. All of the patients were evaluated according to the American Knee Society criteria. Also, patients in both groups were evaluated using the criteria of radiographic assessment of total knee arthroplasty. This study was approved by the Ethics Committee of the Gaziantep University Medical Faculty.

Statistical analysis

The compliance of numerical data with normal distribution was tested using the Shapiro-Wilk test. The Student's t-test was used to compare variables that fit a normal distribution in the two groups. SPSS 22.0 package program was used in the analyzes. $P < 0.05$ was considered significant.

Results

The study includes patients that underwent total knee replacement in our clinic between 2006 and 2017. Fifty-four of 115 patients had posterior cruciate ligament-retaining knee arthroplasty, whereas 61 had posterior cruciate ligament-stabilized knee arthroplasty. Fifty-nine knees of 54 patients and 80 knees of 61 patients were included in the study.

Forty-six of the 54 patients in the ligament-retaining group were female (86%) and 8 were male (14%). Fifty-two of the 61 patients in the ligament-stabilized group were female (85%) and 8 were male (15%).

The mean age was 67.4 years (54-82) in the ligament-retaining group and 65.4 years (42-85) in the ligament-stabilized group. The mean follow-up period for both groups was 32.6 months (12-98).

Fifty-two of the 54 ligament-retaining patients were operated for primary osteoarthritis, while 3 patients were operated for underlying rheumatoid arthritis. Fifty-nine of the 61 ligament-stabilized patients were operated for primary osteoarthritis, 1 for rheumatoid arthritis, and 1 for post-traumatic arthritis.

Five ligament-retaining patients underwent arthroplasty of both knees. Nineteen patients that were performed ligament-stabilized prosthesis underwent arthroplasty of both knees.

The mean preoperative AKSS knee score (including pain, range of motion, and stability) of the 59 knees of the 54 patients in the ligament-retaining group was 48.4 ± 8.1 (36-72), whereas the mean postoperative AKSS knee score was 93.3 ± 4.6 (76-100). The mean preoperative AKSS knee score of the 80 knees of the 61 patients in the ligament-stabilized group was 43.7 ± 5.9 (38-71), whereas the mean postoperative AKSS knee score was 95.0 ± 6.9 (78-100). In light of these data, the postoperative AKSS knee scores of the ligament-sparing and ligament-sacrificing groups are not significantly different ($p = 0.129$) (Table 1)

The mean preoperative AKSS function score ligament-retaining group was 31.2 ± 11.7 (15-60) whereas the mean postoperative AKSS function score was 84.8 ± 9.06 (60-100). The mean preoperative AKSS function score of the ligament-stabilized group was 35.08 ± 4.9 (10-60), whereas the mean postoperative AKSS function score was 82.2 ± 8.9 (60-100). This assessment indicated that the outcomes of the two groups were not significantly different ($p = 0.128$) (Table 2).

Another parameter that we used to evaluate our subjects was the pre- and postoperative knee range of motion. The mean preoperative knee flexion value was 73.42 ± 14.18 degrees (50-105) for the ligament-sparing group and 77.1 ± 7.6 degrees (40-105) for the ligament-sacrificing group. The mean postoperative knee flexion value was 107.67 ± 8.45 degrees (90-120) for the ligament-retaining group and 117 ± 8.03 degrees (90-120) for the ligament-stabilized group ($p = 0.001$). Preoperative joint assessment revealed the mean knee alignment of the PCL-retaining group was an 8.9-degree varus (ranging from 5-degree valgus to a 20-degree varus). The mean preoperative knee alignment of the PCL-stabilized group was

a 9.7-degree varus (8-degree valgus to 20-degree varus), and the mean postoperative knee alignment was a 4.75-degree valgus (10-degree valgus to 2-degree varus). The radiographic assessment revealed that the mean alpha angle value of the PCL-retaining group was 94.5 degrees (90-103) and the mean beta angle value was 88.3 degrees (84-93). The mean gamma angle value was calculated as 5.2 degrees (0-10) and the mean theta angle value was calculated as 86.7 degrees (80-94). In the PCL-stabilized group, the mean alpha angle value was calculated as 93.4 degrees (89-99), the mean beta angle value was 89.2 degrees (86-92), the mean gamma angle value was 88.3 degrees (84-92), and the mean theta angle value was 4.3 degrees (0-11). In light of these findings, we saw that the alpha angle values of the two groups were not significantly different; however, the beta, theta, and gamma angles were significantly different (p = 0.001).

None of the subjects developed embolism and only one patient in the ligament-stabilized group required revision surgery due to late infection.

Table 1. Comparison of pre- and postoperative AKSS knee scores of the groups

59 knees of 54 patients/ 80 knees of 61 patients	Preoperative AKSS knee score	Postoperative AKSS knee score
Mean	48.45/43.7	93.32 /95.0
Standard Deviation	8.17/5.9	4.69/6.9
Minimum	36/38	76/78
Maximum	72/78	100/100

Table 2. Comparison of pre- and postoperative AKSS function scores of the groups

59 knees of 54 patients/ 80 knees of 61 patients	Preoperative AKSS function score	Postoperative AKSS function score
Mean	31.2/35.08	84.8/82.2
Standard Deviation	11.7/4.9	9.06/8.9
Minimum	15/10	60/60
Maximum	60/60	100/100

Discussion

There are several evidence level I and II studies comparing ligament-sparing and ligament-stabilized prostheses [9-15]. Many studies concluded that the two approaches were not significantly different in clinical scores, range of motion, and quadriceps healing outcomes, and only two studies reported a better range of motion outcome in ligament-stabilized prostheses [16].

Four studies compared the long-term results of ligament-retaining and stabilized prostheses. Two studies indicated no difference, and the remaining two found that the ligament-retaining approach had better prosthesis survival outcomes [16,17].

The role of the posterior cruciate ligament is still debated. This is due to the role of the posterior cruciate ligament in knee kinematics. The posterior cruciate ligament is the structure that provides femoral rollback movements, a physiological movement of the distal femur. In addition, it contributes to the stability of the knee joint and knee joint proprioception due to its mechanoreceptors. In PCL-stabilized designs, the geometry of the articular surface of the prosthesis resists displacement. The prosthesis resists the subsequently developing stress, and this causes the stress to load onto the cement-bone interface. Researchers speculated that this would cause PCL-sacrificing prosthesis to fail [18]. Regardless, we found that the functional outcomes of the two groups were similar, and that only in terms of the range of motion, PCL-stabilized prosthesis was superior. The literature indicates several factors that might influence the postoperative outcome of total knee arthroplasty. These include age, obesity, and gender [19]. In order to reduce the bias that may be caused by these factors in our results, we tried and selected patients in the two groups to be similar and homogeneous. In this way, we aimed to obtain more accurate data.

In our study, the success rates of PCL-retaining and PCL-stabilized approaches were similar. The literature indicates that rheumatoid arthritis, post-traumatic arthritis, and previous surgery or patellectomy are all indications for using the PCL-stabilized approach for better outcomes [20]. However, this choice is still associated with the surgeon's preference and experience. Although some of our subjects had underlying diseases, we could not include these factors into comparison due to the insufficient number of subjects.

The most feared complications of total knee replacement are infection and thromboembolism [21]. In our study, none of the subjects developed embolism, and only one patient in the ligament-sacrificing group required revision surgery due to late urinary infection.

Studies report successful clinical and radiological outcomes for knee prosthesis surgeries [22]. We also conducted a comparative analysis of the radiological results and found that, while the alpha angles of the two groups were statistically similar, the other parameters were not. It should be kept in mind that this outcome may vary depending on the surgical technique, preoperative planning, and joint deformity.

Our study has several limitations. The first limitation of our study is its retrospective nature. The second limitation is that, despite having a sizable number of patients, similar studies in the literature have significantly larger samples.

We conclude that both PCL-retaining and PCL-stabilized knee arthroplasties have good clinical outcomes. The clinical and radiological results of both approaches are satisfactory. The decision for the surgical approach should be based on the surgeon's experience, preference, and the preoperative characteristics of the patient.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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